ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at:www.ijmacr.com

Volume – 7, Issue – 3, June - 2024, Page No. : 13 – 26

Comparison of Ultrasound Measurement of Airway Parameters with Conventional Clinical Screening Tests to Predict Difficult Laryngoscopy

[1]Dr Harsh J Panchal, [2]Dr Kalpana S Vora, [3]Dr Manisha P Modi, [4]Dr Pugal Prabu, [5]Dr Prakhar Khandelwal

Corresponding Author: Dr. Harsh J Panchal, Senior Resident, Department of Anaesthesiology, B J Medical College, Civil Hospital, Ahmedabad.

How to citation this article: Dr Harsh J Panchal, Dr Kalpana S Vora, Dr Manisha P Modi, Dr Pugal Prabu, Dr Prakhar Khandelwal, "Comparison of Ultrasound Measurement of Airway Parameters with Conventional Clinical Screening Tests to Predict Difficult Laryngoscopy", IJMACR- June - 2024, Volume – 7, Issue - 3, P. No. 13 – 26.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim and objective: In this study, we seek to test our hypothesis to study the sensitivity and specificity of ultrasound measurement of airway parameters and soft tissue thickness at three different sites (anterior neck at the hyoid, thyrohyoid level and tongue thickness) and compare them with conventional clinical screening test stop edict difficult laryngoscopy.

Method: Patient undergoing surgery with general anesthesia with endotracheal intubation, ASA grade I, II, and age>17years were included in the study. In the pre-operative assessment, parameters recorded were: Mouth opening (1/2/3finger), Modified Mallampati classification (MMP), The thyromental distance is the distance from mental prominence to upper border of thyroid cartilage with neck fully extended and Neck circumference was measured at the level of the thyroid cartilage. All measurements were recorded using a measuring scale in cm by the primary investigator who was not involved in the performance of laryngoscopy. Following informed written consent, we recruited patients on the same day of surgery. After positioning the patient supine with head and neck in sniffing position investigator performed ultrasound measurement of soft tissue thickness of anterior neck at the hyoid, thyrohyoid level and tongue thickness.

Result: Sensitivity and specificity for all bedside clinical tests were found to be inferior than that of ultrasound-based parameters except skin to hyoid bone distance which has similar specificity to neck circumference

Keywords: Difficult Intubation, Laryngoscopy, Ultrasound, Airway Management.

Introduction

From the time of introduction of endotracheal intubation, several problems have occurred due to failed intubation. Expertise in airway management to some extent is the prime clinical skill that defines an Anaesthetist. As rightly stated by M. Rosen and I. P. Lotto "There is one skill

above all else that ananaesthetist is expected to exhibit and that is to maintain the airway patency" (1) To avoid facing the situation of unanticipated difficult airway the anaesthesiologists developed the method of preoperative airway assessment. To predict difficult airway based on the structures that are visible in the oropharynx while the patient's mouth is wide open and tongue ids protruded out, various clinical predictors of difficult airway have been developed and analysed like, inter incisor gap, sternomental distance, extent of neck mobility, etc. (2,3) Initially the airway assessment was carried out by single factors like Mallampatti's oropharyngeal classification. Thyromental distance, Head and neck movement and Inter incisor gap. [2, 3, 4] But when it was realized

that the visualization of larynx during intubation is affected by many factors, the concept of multivariate factor analysis came into existence[5,6,7,8,9]Even with the use of multivariate factors there have been instances when a patient predicted to have easy intubation had a difficult intubation and vice versa.

USG may bring a new change in difficult airway research because of the high quality of imaging, non-invasiveness and relatively low cost, ultrasonography has been utilized as a valuable adjunct to the clinical assessment of the airway [13,14,15].

In this study, we seek to test our hypothesis to study the sensitivity and specificity of ultrasound measurement of airway parameters and soft tissue thickness at three different sites (anterior neck at the hyoid, thyrohyoid level and tongue thickness) and compare them with conventional clinical screening tests to predict difficult laryngoscopy.

Methodology

After obtaining approval from the ethical committee and written informed consent, a prospective randomized double blinded comparative study was initiated. 300 patients of ASA Grade I - II, undergoing elective surgery requiring general anesthesia with direct laryngoscopy (Macintosh blade) and endotracheal intubation were enrolled by sealed envelope technique.

Patient undergoing surgery with general anesthesia with endotracheal intubation, ASA grade I, II, and age>17years were included in the study. Patients with past history of difficult intubation, anatomical abnormality of upper airway, with cervical spine instability, with facial fractures, pregnant and obese were excluded from the study.

In the pre- operative assessment, parameters recorded were:

1. Mouth opening (1/2/3finger),
2. Modified Mallampati classification (MMP)
3. The thyromental distance is the distance from mental prominence to upper border of thyroid cartilage with neck fully extended.
4. Neck circumference was measured at the level of the thyroid cartilage.

All measurements were recorded using a measuring scale in cm by the primary investigator who was not involved in the performance of laryngoscopy. Following informed written consent, were cruited patients on the same day of surgery. After positioning the patient supine with head and neck in sniffing position investigator performed ultrasound measurement of soft tissue thickness of anterior neck at the hyoid, thyrohyoid level and tongue thickness. All the Sonographic structures are identified by using different probes with Philips Affinity 70G Ultrasound Machine.

1. Distance from skin to hyoid bone (SHB) was measured by placing the linear high-frequency (5-12 Hz) ultrasound probe transversely over the hyoid

bone. The hyoid bone was identified as a curved Hyper echoic inverted U shaped structure with posterior acoustic shadow

2. Distance from skin to the thyrohyoid membrane (STM) was measured midway between hyoid and thyroid cartilage at the level of the epiglottis and epiglottis was identified as a curvilinear hypo echoic structure with a bright posterior air mucosal interface and hyperechoic pre-epiglottic space by using linear high frequency probe.
3. Tongue thickness was measured by recording the geniohyoid muscle thickness using a curvilinear probe (5–2 MHz) in the midline sagittal plane

General Anaesthesia was administered as follows:

1. Premedication: Injection Glycopyrrolate (0.04 mg/kg), Injection Fentanyl (2 - 3 μg/kg)
2. Induction: Injection Thiopentone Sodium 5-7 mg/kg till the loss of eyelash reflex and Injection Succinylcholine 1-1.5 mg/kg.
3. After the induction of general anaesthesia, an experienced anaesthesiologist who had more than 5 years of experience, who was blinded to the ultrasound measurements, performed direct laryngoscopy with Macintosh blade 3 and 4.
4. The Cormack Lehane (CL) grade of larynx observed without application of any external laryngeal manipulation was recorded, (Grade I: full view of the glottis, grade II: a partial view of the glottis or arytenoids, grade III: only epiglottis visible and grade IV: with neither glottis nor epiglottis seen). A CL grade I or II was considered as easy and grade III or IV as difficult laryngoscopy.
5. External laryngeal press/manipulation was permitted to improve the view of glottis. The tracheal tube size was selected based on the anesthetist's clinical experience.
6. Theairwaywassecuredwithpolyvinylchlorideendotrachealtubesofsizes 6.5 -8.5 mm internal diameter and the cuff was filled with saline enough to allow an air leak of 50 ± 10 ml.
7. Maintenance: Injection Atracurium (0.5mg/kg), O2, Air, Isoflurane.

Statistical Analysis

The data was collected with predesigned proforma and entered in Microsoft Excel 2016 and analyzed with Excel 2016. Continuous data such as age, thyromental distance, distance from skin to thyrohyoid membrane, neck circumference and distance from skin to hyoid bone and tongue thickness were expressed as mean with standard deviation [SD]. Categorical data, such as gender and modified Mallampati score, are expressed as number of occurrence (frequency and percentage). Based on distribution of data, (normal or skewed) parametric or non-parametric tests were applied. Normality was assessed by Shapiro Wilk Test. Student unpaired t test was used for parametric data and for non-parametric data, Mann Whitney U Test was used. Categorical data was compared using Chi square test. P value less than 0.05 was considered as significant.

Sensitivity and specificity for all bedside clinical tests and ultrasound- based parameters were calculated and compared. For that, CL Grading was taken as Gold Standard Test. According to CL grade, patients were categorised into two groups (Easy laryngoscopy, difficult laryngoscopy).

Test Criteria		Gold standard test (CL grade)		Total
		DL(grade3&4)	EL(grade1& 2)	
Diagnostic test	DL	A(true positive)	B(false positive)	A+B
	EL	C(false negative)	D (true negative)	C+D
Total		A+C	B+D	N= Total sample size

Receiver operating characteristics (ROC) curves was plotted for all the clinical assessment tests and ultrasound measurements of anterior soft tissue neck and tongue thickness. Predictive accuracy was measured by area under curve (AUC) with 95% confidence interval.

Sample size: Sample size was calculated based on pilot study done by Adhikari et al assuming 5% level of significance and 80% power of the study using difference between the two means of skin to hyoid bone distance. Total sample size was 300 patients with 266 patients in easy laryngoscopy group and34 patients in difficult laryngoscopy group with expected proportion of difficult to easy laryngoscopy to be 1:8.

Results

Table1: Demographic characteristics of patients

Characteristics	N=300
Age (Means ±SD) in years	45.29±13.18
Gender	No of cases (%)
Male	183(61%)
Female	117(39%)
Male: Female ratio	1.56:1
Height(Means ± SD)in meter	1.64±0.06
Weight (Means ± SD) in kgs	65.14±10.7
BMI (Means ± SD) in kg/m^2	24.06±2.9

Total 300 patients were enrolled in the study. Patients' characteristics are shown in table 1. Mean age of patients was 45.29 ± 13.18 years. 183 patients (61%) were male and117 patients (39%) were female. Male: female ratio was 1.56:1. The mean height was 1.64 ± 0.06 meter. The mean weight was 65.14 ±10.7 kg. The mean BMI was 24.06 ±2.9 kg/m2.

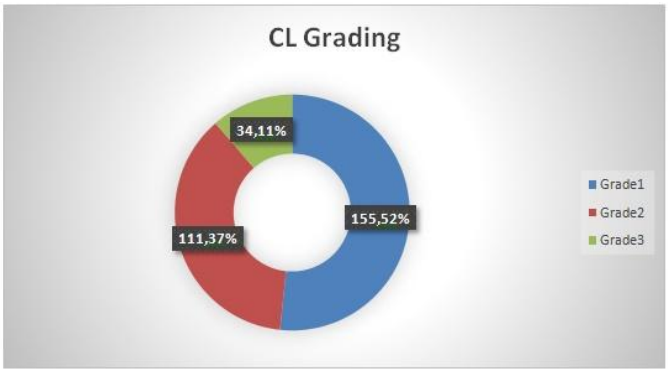

Fig. 1: CL Grading by direct laryngoscopy

Sonographic measured parameters

Fig. 2: Thickness of anterior neck soft tissue from skin to hyoid bone

Out of 266 cases in Group E, the mean value of thickness of anterior neck soft tissue from skin to hyoid bone is 0.79±0.17 cm SD. Out of the 34 cases in group D, the mean value of thickness from skin to hyoid bone

is 1.03±0.15 cm SD which is highly significant.

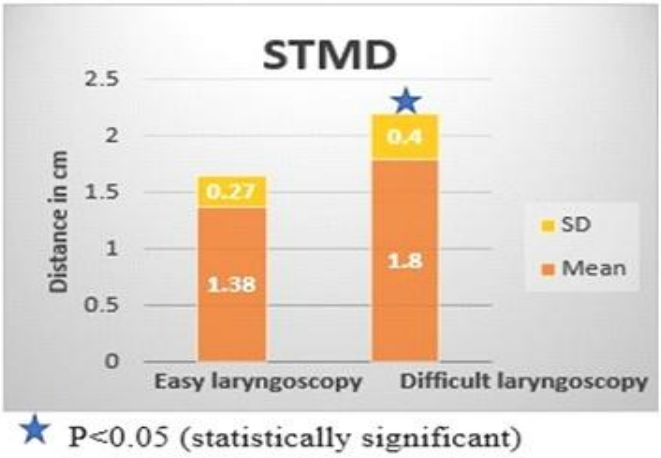

Fig. 3: Thickness of anterior neck soft tissue from skin to thyrohyoid membrane level at the level of epiglottis

Out of the 266 cases in Group E, the mean value is 1.38±0.27 cm SD. out of 34 cases in Group D, the mean value 1.8±0.40 cm SD which is highly significant.

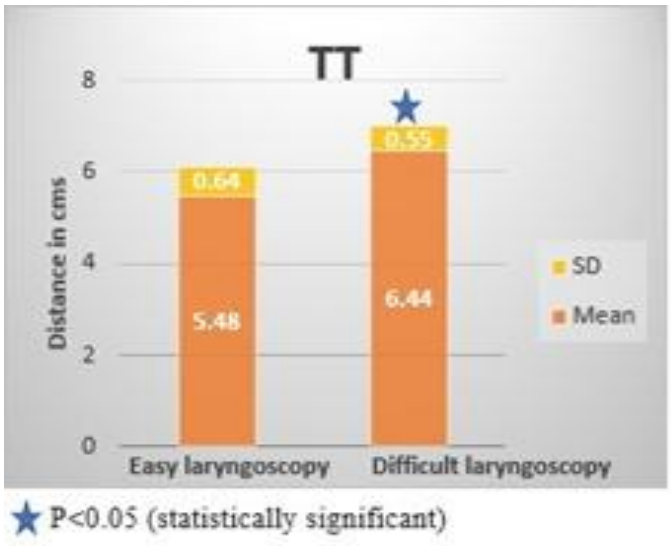

Fig. 4: Tongue Thickness in both groups

Out of the 266 cases in group E, the mean value is 5.48±0.64cm SD. Out of the 34 cases in Group D, the mean value 6.44±0.55 cm SD which is highly significant.

Clinically Measured Parameters

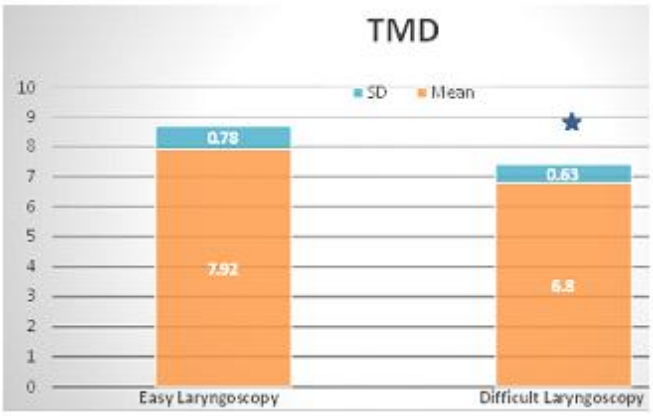

Fig. 5: Thyromental distance in both groups

Out of the 266 cases in Group E, the mean value is 7.92 ± 0.78 cm SD. Out of the 34 cases in Group D, the mean value 6.8 ± 0.63 cm SD. P value =0.02, statistically significant.

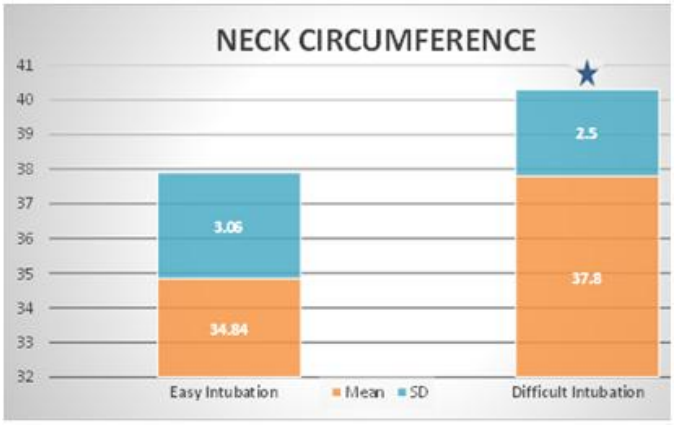

Fig. 6: Neck Circumference in Both Groups

Out of the 266 cases in Group E, the mean value is 34.84 ± 3.06 cm SD. Out of the 34 cases in Group D, the mean value 37.8 ± 2.5 cm SD. P value =0.0005, statistically significant.

Table 2: Descriptive data of clinical parameters and ultrasound parameters			
Clinical parameters	Easy Laryngoscopy (N=266)	Difficult Laryngoscopy (n=34)	P value
MMP 1	97 (32.33%)	3 (1%)	
MMP 2	89 (29.67%)	14 (4.67%)	
MMP 3	80 (27.33%)	17 (5.67%)	
Thyromental Distance (in cm)	7.92 ± 0.78	6.8 ± 0.63	0.02
Neck Circumference (in cm)	34.84 ± 3.06	37.8 ± 2.5	0.0005
USG Parameters	Easy Laryngoscopy (N=266)	Difficult Laryngoscopy (n=34)	P value
SHB (in cm)	0.79 ± 0.17	1.03 ± 0.15	0.00001
STMD (in cm)	1.38 ± 0.27	1.8 ± 0.4	0.00001
Tongue Thickness (in cm)	5.48 ± 0.64	6.44 ± 0.55	0.00001

P-value <0.05 is considered significant; Cormack-Lehane grades of 1&2 were defined as easy laryngoscopy and grades 3 and 4 were defined as difficult laryngoscopy. MMP – Modified Mallampati, SHB – Skin to hyoid bone distance (cm), STMD – Skin to thyrohyoid membrane distance (cm).

In difficult laryngoscopy group, all the distances are more compared to easy laryngoscopy group except thyromental distance.

Calculation of Specificity and Sensitivity of Clinical Parameters

Table 3: Sensitivity and Specificity of all Clinical and USG Parameters		
Clinical Parameters	Sensitivity	Specificity
MMP	50 %	70 %
TMD (< 6.5 cm)	41 %	50.75 %
Neck Circumference	59 %	60 %
USG Parameters	Sensitivity	Specificity
SHD	82 %	59.4 %
STMD	67.5 %	96 %
TT	79 %	83.1 %

Sensitivity and specificity for all bedside clinical tests were found to be inferior than that of ultrasound-based parameters except skin to hyoid bone distance which has similar specificity to neck circumference.

ROC Curves: ROC curve was plotted for all the clinical assessment tests and ultrasound measurements of anterior soft tissue neck and tongue thickness

Table 4: AUC & Confidence interval of all Parameters		
Clinical Parameter	AUC	CI (95%)
MMP	0.659	0.578-0.739
TMD (< 6.5 cm)	0.68	0.608-0.815
Neck Circumference	0.774	0.697-0.852
USG Parameter	AUC	CI (95%)
SHD	0.854	0.779-0.929
STMD	0.815	0.708-0.922
TT	0.874	0.817-0.931

The ultrasound measurements had greater AUC than bedside clinical assessment tests, thus showing greater validity to predict difficult laryngoscopy.

ROC Curves of Clinical Parameters

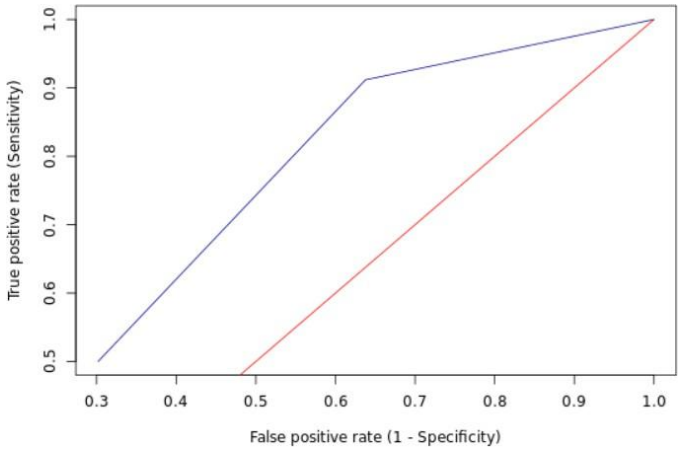

Fig.7: ROC curve of MMP. AUC is 0.659 to predicting difficult laryngoscopy

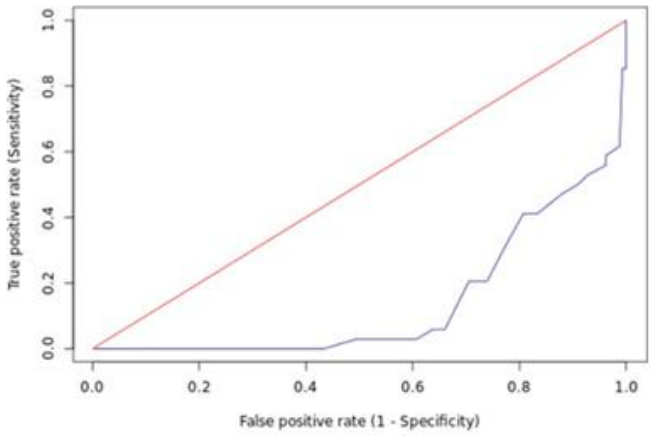

Fig. 8: ROC curve of TMD. AUC is 0.68

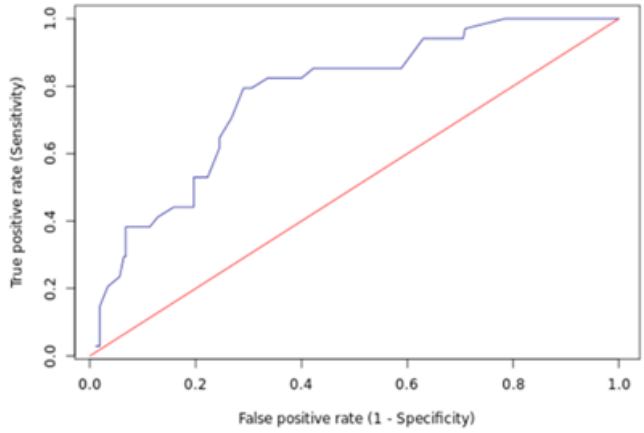

Fig. 9: ROC curve of NC. AUC is 0.774

ROC Curves of USG Parameters

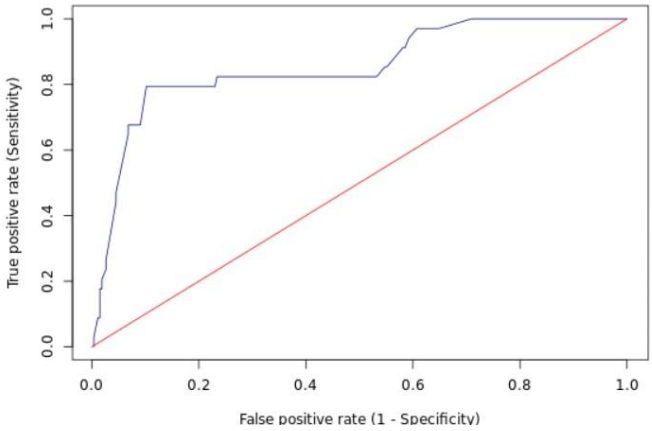

Fig. 10: ROC curve of SHD. AUC is 0.854 to predicting difficult laryngoscopy

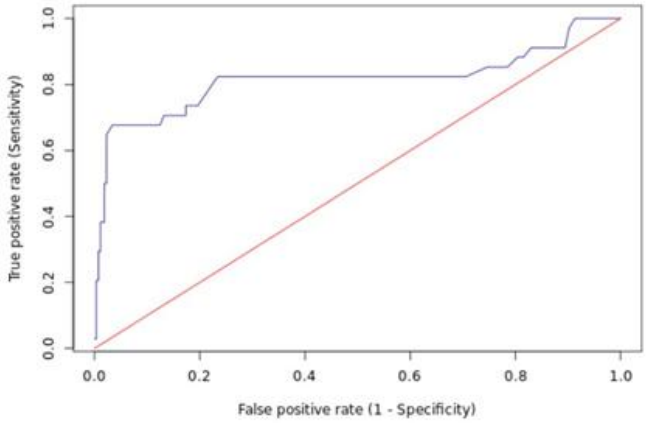

Fig. 11: ROC curve of STMD. AUC is 0.815 to predict difficult laryngoscopy

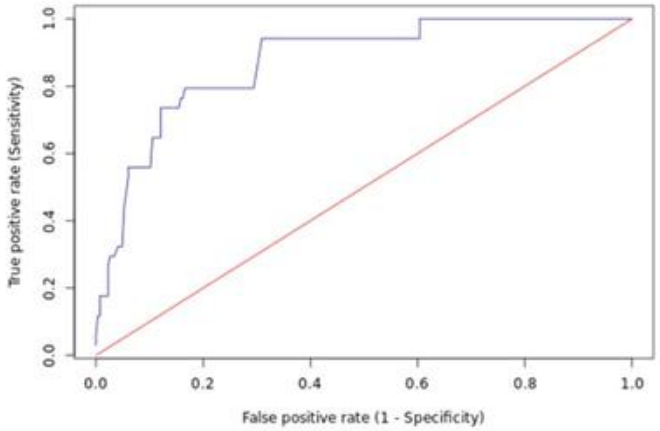

Fig. 12: ROC curve of TT. AUC is 0.874 to predicting difficult laryngoscopy

Discussion

All pre op airway assessment tools are characterised by low sensitivity, reasonable specificity, low positive predictive value and significant false positive (22,34).

Pre op ultrasound can allow more precise assessment of airway structures and can help the anaesthesiologist to formulate a safe plan for securing the airway(32). Many studies regarding ultrasound airway assessment have been conducted so far in many countries(13,14,15). In this study we assess usefulness of ultrasonogram in predicting difficult laryngoscopy conducted in Indian population. We used USG as a preop airway assessment as it is easily available, parameter can be easily recorded at the bedside, do not involve complex calculations and have been found to predict difficult laryngoscopy as observed by Adhikari et al(15). Various studies on airway ultrasound have evaluated parameters such as tongue thickness, volume of tongue, skin to hyoid bone distance in supine and in neck extended position and ratio of these two distances, skin to thyrohyoid membrane distance, distance from the epiglottis to the midpoint of vocal cord (E-VC), depth of the pre-epiglottic space and ratio of these distances for predicting difficult laryngoscopy(35,36). We did study in sniffing position because it's a position of laryngoscopy.(37) Most of the studies has considered CL Grading as a gold standard test for predicting difficult laryngoscopy.(13,15,23,24,36,38,39)So, we are taking CL grading as Gold Standard test. And calculating Sensitivity and Specificity of all parameters in context to CL grading for predicting Difficult laryngoscopy. According to Yadav et al.(36) cut off value for SHD & STMD is 0.77 & 1.9 cm. Yao et al. observed that Tongue thickness >6.1 cm predicting difficult laryngoscopy(40). Zahid Hussain Khan et al. predicting difficult laryngoscopy for TMD < 6.5 cm(41). MPG 3 & 4 are in difficult Laryngoscopy while 1& 2 in Easy like SM Crawley et al.(42) So, we are also taking these as cut off points. Wichai et al in their study found that MMP was a more useful predictor than TMD with a sensitivity, specificity, and positive predictive value of 41.7%, 95.5%, 23.1% respectively.(43). These results are similar to the studies done by Tse et al.(7)(both sensitivity and specificity of 66%) and Merah et al.(19) (sensitivity and specificity of 61.5 and 98.4 respectively). Mallampatti reported a sensitivity of 53% and positive predictive value of 93%. The wide range of results has been attributed to inter observer variability as reported by Karkouti et al(44). Our study has also a low sensitivity (41%) and specificity (51%) of thyromental distance. The TMD has low sensitivity of 23% in study conducted by Wichai et al(43). Tse et al and Merah et al also reported a similar low sensitivity of 32% and 15% respectively(7,19). This was also supported by Yao et al(40). Reddy et al found that Mallampatti is a good indicator for difficult laryngoscopy, but TMD was not because it has low sensitivity of 28.6% but high specificity(35). Yadav et al showed low sensitivity of 45% and specificity of 46%(36). Authors suggested that the low sensitivity obtained in their study might be due to anthropometric peculiarities in their population. While TMD has higher sensitivity (64.7%) in Savya et al study compared to other study(45). Large neck circumference, increased pre tracheal soft tissue and occipital tissue are associated with difficulties the latter impacting on achieving optimal positioning through limitation of neck extension. Our study has also a low sensitivity (59%) and specificity (60%) of neck circumference. Similar results were obtained in the study done by Yadav et al who showed sensitivity of 60% and specificity of 62

%(36). Thus Anterior neck soft tissue at neck is a better indicator than circumference as fat distribution can differ amongst the individuals despite circumference (14). A suggested explanation is that increased anterior neck soft tissue results in decreased airway structure and mobility (13).

Most of the study about neck circumference is done in obese patients or obstetrics patients. Meco et al performed study on the thyroid surgery patients that's why their cut offs are high (43 cm) (46). But our study were done in normal BMI, non-pregnant, non-thyroid patients so cut off point are less in our study (37.5 cm).

We evaluated in this study USG measurements of soft tissue anterior to the airway at the level that needs to be displaced by laryngoscope blade ie. At the hyoid, or thyrohyoid membrane which might predict difficult laryngoscopy. We have in this study sonographic measurements of anterior neck soft tissue were greater in difficult laryngoscopy group compared to easy laryngoscopy.

In our study, SHB's, sensitivity, specificity and area under curve was 82%, 59% and 85%. Yadav et al also found similar results like 68%, 69% and 72%(36). Wu et al also clinically significant difference with area under curve of 92% in their Chinese population(24). In our study, STMD's sensitivity, specificity and area under curve was 67%, 96% and 81%. Yadav et al also found a similar result like 65%, 69% and 73%(36). Similarly Wu et al also found clinically significant difference with area under curve of 90%(24). Like us Pinto et al also states distance from skin to epiglottis demonstrate significance ($p < 0.001$) with highest average values for accuracy, specificity, and positive predictive value(38).

Adhikari suggests that an anterior neck soft tissue thickness of 28 mm at the thyrohyoid membrane can serve as a cut off to detect difficult laryngoscopy(15). It seems clinically prudent to perform the measurements in the position that the patient will be during laryngoscopy: supine with the neck extended. While three authors found significance at the thyrohyoid membrane, the measurements are seemingly contradictory. Adhikari's easy laryngoscopy group had a measure of 23.7 mm, Wu's difficult laryngoscopy group was 23.9 mm(24), and Pinto derived 27.5 mm(38). This may be explained in part by the demographics of the groups. Adhikari's study is an American study with a predominantly female sample (32 females with 19 males) and mean age of 53. However, eighty-three percent (5 of the 6) difficult laryngoscopies were male

In our study, we had the highest validity is of tongue thickness as a predictor of difficult laryngoscopy. This is also proved by Yao et al, who stated that tongue had more direct relationship with difficult intubation in their data, BMI was also a weak predictor(40). They observed significant correlation between BMI and tongue thickness. These may interpreted as, high BMI can cause thicker tongue and impaired tracheal intubation. Patients who had high BMI, but not thick tongue are likely to be intubated easily. This is to say that thick tongue might have more direct relationship with difficult intubation then does high BMI.

Ezri and colleagues demonstrated that the soft tissue thickness of the anterior neck as quantified by ultrasound was an indicator of difficult laryngoscopy in a select group of obese patients (13). However, the results of Komastu et al contradict these results they found that the thickness of anterior neck soft tissue measured by ultrasound did not predict difficult laryngoscopy in obese patients indicating that the results of our study may not be applicable to the obese population(14).

Contradictory to our study Wojtczak and colleagues14 investigated tongue volume in obese patients found that it did not differ significantly between groups with and without difficult laryngoscopy (21). The contradiction may be explained as follows: an increased tongue thickness and a shorter tongue, but not necessarily exhibiting an increased tongue volume, indicates a greater possibility of difficult laryngoscopy or difficult tracheal intubation. In our study, tongue thickness sensitivity, specificity and area under curve are 79%, 83% and 87%. Similarly, Yadav et al. showed 71%, 72% and 72%(36). Yao et al showed a sensitivity and specificity of 75% and 72% in their study(40).

Similarly, Wu et at studied 203 patients and found that ultrasound measurement at the level of hyoid bone, thyrohyoid membrane and anterior commissure can independently predict difficult laryngoscopy(24). These parameters had a greater area under the ROC curve when compared with conventional screening tests. But our values were found to be lesser than that observed by previous studies which could be due to the population involved in this study. We had enrolled the patients from the western part of India, whereas in the other two studies African American population and Chinese Han population was involved. Result of Sensitivity and Specificity of USG parameters were higher than clinical conventional screening tests to detect difficult laryngoscopy. Due to their poor sensitivity and specificity the various clinical tests to predict difficult laryngoscopy are less reliable. Like our study previous studies also suggested sonographic measurements fared better in terms of sensitivity and specificity and AUC to detect difficult laryngoscopy (24, 36, 40). In our study SHD, STMD & TT's sensitivity and specificity were 82, 67.5, 79 & 59.4, 96, 83.1% which was more than clinical parameters. Similar to us Wu et al. observed that skin to hyoid bone distance has a sensitivity and specificity of 85.7% and 85.1%, respectively, which was greater than that of MMP and other airway predictors(24).

The ROC curve is a graphical display of sensitivity and specificity, and the AUC is an effective measure for assessing the inherent validity of the test. The accuracy of the test depends on how well the test separates the groups being tested. Accuracy is measured by the area under the ROC curve. An area of 1 represents a perfect test; an area of 0.5 represents a worthless test.

Wu et al found strong positive linear correlations existed among the thicknesses of anterior neck soft tissue measured by US at hyoid bone, thyrohyoid membrane, and anterior commissure levels(24). The AUCs of MMS, DSHB, DSEM, and DSAC are all over 0.7, indicating they are all good parameters in predicting difficult laryngoscopy. The AUCs of TMD and IIG were less than 0.7, suggesting that TMD and IIG were poor parameters in predicating difficult laryngoscopy

We found high area under curve for USG parameters as compared to clinical parameters. Similar results were obtained by other studies (36,40). Yao et al concluded high area under curve for tongue thickness as compared to clinical parameters (40). Amongst the clinical parameters, Neck circumference had the highest AUC but was less than the USG parameters suggesting that

These tests were better in predicting difficult laryngoscopy when compared with the clinical screening test. Because of the simplicity of the test and better results with less time is needed to perform USG. Hence USG could be used in day-to-day setup in routine pre op airway assessment. Unfortunately, none of the ultrasound measurements of anterior neck thickness parameters have a very high sensitivity or specificity to

be used as a standalone test for detecting difficult laryngoscopy.

Conclusion

A total of 300 patients who required General Anesthesia with Tracheal intubation for elective surgery were enrolled in this prospective randomised observational study to compare Sonographic approaches to clinical conventional screening test for prediction of difficult laryngoscopy. With linear probe in transverse plane the distance from skin to hyoid bone, skin to the thyrohyoid membrane in sniffing position and maximum tongue thickness by curvilinear probe in sagittal plane was measured by ultrasound and difficult laryngoscopy was evaluated with Cormack Lehane (CL) laryngoscope view in 300 adult surgical patients. The sensitivity and specificity of ultrasound-guided parameters were compared with clinical parameters like the modified Mallampati classification, thyromental, and neck circumference. Receiver operating characteristic curve was plotted and the area under the curve was calculated for each parameter. Incidence of difficult laryngoscopy (CL grade-III and IV) was 11.33% in this study. A significant difference was observed in the ultrasound parameters between the easy and difficult laryngoscopy (P-value = 0.00001). Sensitivity and specificity to predict difficult airway was 82% and 59.4% for the skin to hyoid bone distance, 67.5% and 96% for skin to thyrohyoid membrane distance and 79% and 83.1% for tongue thickness in a sniffing position and found to be higher than clinical parameters. The highest validity of the test was 0.874 (tongue thickness)

The ultrasound measurements of soft tissue thickness of the anterior neck at the hyoid and thyrohyoid membrane and tongue thickness are superior in preop assessment of difficult airway so they can be used along with the clinical assessment of airway for predicting difficult laryngoscopy.

References

1. Harmer M, Latto IP. Teaching intubation. In: Latto IP, Rosen M, eds. Difficulties in Tracheal Intubation. Eastbourne: Bailliere Tindall, 1985; 173- 18023. Harmer M, Vaughan RS. Guid
2. Mallampatti's SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, Liu PL. A clinical sign to predict difficult tracheal intubation: a prospective study. Canadian Anesthetists Society Journal 1985; 32: 429-434.
3. Samsoon GLT, Young JRB. Difficult tracheal intubation: A retrospective study. Anesthesia 1987; 42: 487-490.
4. Rathee, Shivani & Bansal, Sapna & Antil, Parveen & Malhotra, S & Inderja,. (2019). Assessment of difficult airway by using various bedside screening tests for endotracheal intubation. Indian Journal of Clinical Anaesthesia. 6. 270-273. 10.18231/j.ijca.2019.050.
5. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. British Journal of Anaesthesia 1988; 61: 211-6.
6. Frerk CM. Predicting difficult intubation. Anesthesia 1991; 46: 1005-8.
7. Tse JC, Rimm EB, Hussain A. Predicting difficult endotracheal intubation in surgical patients scheduled for general anesthesia: a prospective blind study. Anesthesia and Analgesia 1995; 81: 254-58.
8. El Ganzouri AR, Mc Carthy RJ, Tuman KJ, Tanck EN, Ivankovich AD. Preoperative airway assessment: Predictive value of a multivariate risk

index. Anesthesia and Analgesia 1996; 82: 1197-1204.

9. Arne J, Descoins P, Fusciardi J, Ingrand P, Ferrier B, Boudigues D et al. Preoperative assessment for difficult intubation in general and ENT surgery: Predictive value of a clinical multivariate risk index. British Journal of Anesthesia 1998; 80: 140-146.
10. J.P.Kline. " Ultrasound guidance in anaesthesia" AANA Journal, vol. 79, no.3, pp. 209 - 217, 2011.
11. C.R. Falyar, "Ultrasound in anaesthesia : applying scientific principles to clinical practice". AANA journal Vol 78, no. 4 pp. 332 - 340, 2010.
12. A. Hatfield and A.Bodenham, " Ultrasound : an emergency role in anaesthesia and intensive care" British journal of Anaesthesia, Vol 83, no.5, pp - 789 - 800; 1999.
13. Ezri T, Gewurtz G, Sessler D J, et al. Prediction of difficult laryngoscopy in obese patients by ultrasound quantification of anterior neck soft tissue. Anaesthesia 2003; 58: 1111-4
14. Komatsu R, Sengupta P, Wadhwa A, et al. Ultrasound quantification of anterior soft tissue thickness fails to predict difficult laryngoscopy in obese patients. Anaesth. Intensive care, 2007; 35: 32 -7.
15. Srikar Adikari et al; Pilot study to determine the utility of point-of-care Ultrasound in the assessment of difficult laryngoscopy. Academic emergency medicine 2011; 18: 754 - 758.
16. Wang J, Xia M, Jiang H. Advances in studies on imaging and artificial intelligence technology-assisted difficult airway assessment. Front Oral Maxillofac Med 2021;3:8.
17. Goldberg BB, Gramiak R, Freimanis AK. Early history of diagnostic ultrasound: the role of American radiologists. AJR Am J Roentgenol. 1993 Jan;160(1):189-94. doi: 10.2214/ajr.160.1.8416623. PMID: 8416623.
18. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984 Nov;39(11):1105-11.
19. Merah NA, Wong DT, Ffoulkes-Crabbe DJ, Kushimo OT, Bode CO. Modified Mallampati test, thyromental distance and inter-incisor gap are the best predictors of difficult laryngoscopy in West Africans. Can J Anaesth. 2005 Mar;52(3):291-6. doi: 10.1007/BF03016066. PMID: 15753502.
20. Hui CM, Tsui BC. Sublingual ultrasound as an assessment method for predicting difficult intubation: a pilot study. Anaesthesia. 2014 Apr;69(4):314-9.
21. Wojtczak JA. Submandibular sonography: assessment of hyomental distances and ratio, tongue size, and floor of the mouth musculature using portable sonography.Journal of Ultrasound in Medicine. 2012 Apr;31(4):523-8.
22. Shiga T, Wajima ZI, Inoue T, Sakamoto A. Predicting difficult intubation in apparently normal patients: a meta-analysis of bedside screening test performance. The Journal of the American Society of anaesthesiologists. 2005 Aug 1;103(2):429-37.
23. Gupta DE, Srirajakalidindi AR, Ittiara BR, Apple LE, Toshniwal GO, Haber HA. Ultrasonographic modification of Cormack Lehane classification for preanesthetic airway assessment. Middle East J Anaesthesiol. 2012 Oct;21(6):835-42.
24. Wu J, Dong J, Ding Y, Zheng J. Role of anterior neck soft tissue quantifications by ultrasound in

predicting difficult laryngoscopy. Medical science monitor: international medical journal of experimental and clinical research. 2014;20:2343

25. Mohammadi SS, Saliminia A, Nejatifard N, Azma R. Usefulness of ultrasound view of larynx in pre-Anesthetic airway assessment: a comparison with Cormack-Lehane classification during direct laryngoscopy. Anesthesiology and pain medicine. 2016 Dec;6(6).
26. Ellis H, Feldman S. The respiratory pathway. Anatomy for anesthetists. 6th edition. Oxford Blackwell Scientific 1993.
27. Bannister HL. Respiratory system. Gray's anatomy. 38th edition. ELBS – Churchill Livingstone 1995.
28. Donald MY, Fung MD, Devitt JH. The Anatomy, Physiology and Innervation of the larynx. Anesthesiology Clinics of North America 1995; 13(2): 259-276.
29. Magill IW. Endotracheal anesthesia. Am J Surg 1936;34:450–5
30. Horton WA, Fahy L, Charters P. Defining a standard intubating position using "angle finder." Br J Anaesth 1989;62:6–12
31. Zagzebski JA. Essentials of Ultrasound physics.St Louis, mo; mosby; 1996.
32. Singh M, Chin KJ, Chan VW, Wong DT, Prasad GA, Yu E. Use of sonography for airway assessment: an observational study. J Ultrasound Med. 2010 Jan;29(1):79-85. doi: 10.7863/jum.2010.29.1.79. PMID: 20040778.
33. Kundra, Pankaj; Mishra, Sandeep Kumar; Ramesh, Anathakrishnan1. Ultrasound of the airway. Indian Journal of Anaesthesia 55(5):p 456-462, Sep–Oct 2011. | DOI: 10.4103/0019-5049.89868
34. Butler PJ, Dhara SS. Prediction of difficult laryngoscopy: an assessment of the thyromental distance and Mallampati predictive tests. Anaesthesia and intensive care. 1992 May;20(2):139-42.
35. Reddy PB, Punetha P, Chalam KS. Ultrasonography - A viable tool for airway assessment. Indian J Anaesth. 2016 Nov;60(11):807-813. doi: 10.4103/0019-5049.193660. PMID: 27942053; PMCID: PMC5125183.
36. Yadav, N. K., Rudingwa, P., Mishra, S. K., & Pannerselvam, S. (2019). Ultrasound measurement of anterior neck soft tissue and tongue thickness to predict difficult laryngoscopy - An observational analytical study. Indian Journal of Anaesthesia, 63(8), 629-634.
37. Akhtar, M., Ali, Z., Hassan, N., Mehdi, S., Wani, G. M., & Mir, A. H. (2017). A Randomized Study Comparing the Sniffing Position with Simple Head Extension for Glottis Visualization and Difficulty in Intubation during Direct Laryngoscopy. Anesthesia, Essays and Researches, 11(3), 762-766.
38. Pinto J, Cordeiro L, Pereira C, Gama R, Fernandes HL, Assunção J. Predicting difficult laryngoscopy using ultrasound measurement of distance from skin to epiglottis. J Crit Care. 2016 Jun;33:26-31. doi: 10.1016/j.jcrc.2016.01.029. Epub 2016 Feb 11. PMID: 26948251.Huh, J., Shin, H.-Y., Kim, S.-H., Yoon, T.-K., & Kim, D.-K. (2009). Diagnostic Predictor of Difficult Laryngoscopy:

The Hyomental Distance Ratio. Anesthesia Analgesia, 108(2), 544–548.

39. Yao W, Wang B. Can tongue thickness measured by ultrasonography predict difficult tracheal intubation? Br J Anaesth. 2017 Apr 1;118(4):601-609. doi: 10.1093/bja/aex051. PMID: 28403413.